NATURE'S WAY RESOURCES
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NEWS FROM THE WONDERFUL WORLD OF SOIL AND PLANTS

We continue with our study of the elements found in animals and humans and how they affect our gardening success. Newsletter articles 166 and 167 have the introductions in them and can be found on the website.

For those that do not have a technical background I am going to cover each element as they are listed in what is known as the periodic table. It is a method commonly used to organize the elements. Each element is shown using a one or two-letter abbreviation that reflects its name (most are straightforward but a few uses Latin or the names in other languages). Most gardeners will recognize many of the common elements, such as nitrogen (N), calcium (Ca), phosphorous (P), iron (Fe), etc. This abbreviation or shorthand makes it very easy to understand what elements are actually in a mineral, a bag of fertilizer, or other amendment.

To help understand how an atom is organized, think of our solar system. We have the sun at the center and the planets revolve around it at different distances (orbits). For atoms, the protons and neutrons are in the center and the electrons revolve around them similar to the planets around our sun. The distance the planets are from the sun determines if they are hot or cold and icy. Similarly, the distance the electrons are from the center of the atom helps determines many of an element's chemical properties. This is why is one form of Chromium (Cr) may be good for you and another form of chromium very bad.

Scientists have discovered 118 total elements of which 94 occur naturally in nature. Of these only 81 elements are considered stable. Seventy-nine of them have been found in animal and human tissue.

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In nature, the individual elements (atoms) are rarely found in a pure form like veins of copper or nuggets of gold. They are most often found combined with other elements into what we call minerals. Today scientists have identified over 5,327 distinct minerals from the simple to the complex. We are all familiar with these simple minerals like common table salt that is sodium chloride (NaCl) or limestone, which is calcium carbonate ($CaCO_3$).

It is important to remember that minerals are not elements but made up of elements. For example, there are hundreds of minerals that contain the element calcium (Ca) along with other elements, but provide only calcium. For gardeners here are a few examples that you are probably familiar with; limestone (calcium carbonate, $CaCO_3$), dolomite (calcium magnesium carbonate, $CaMg(CO_3)_2$, gypsum (calcium sulfate, $CaSO_4$), etc.

By using the abbreviations for the elements, it makes it very easy to understand what is in a mineral. For example, limestone or calcium carbonate ($CaCO_3$) has one atom of calcium (Ca), one atom of carbon (C), and three atoms of oxygen (O) to make one molecule. For a dolomite molecule or mineral has one atom of calcium (Ca), one atom of magnesium (Mg), and two carbonates (CO_3) shown as $(CO_3)_2$.

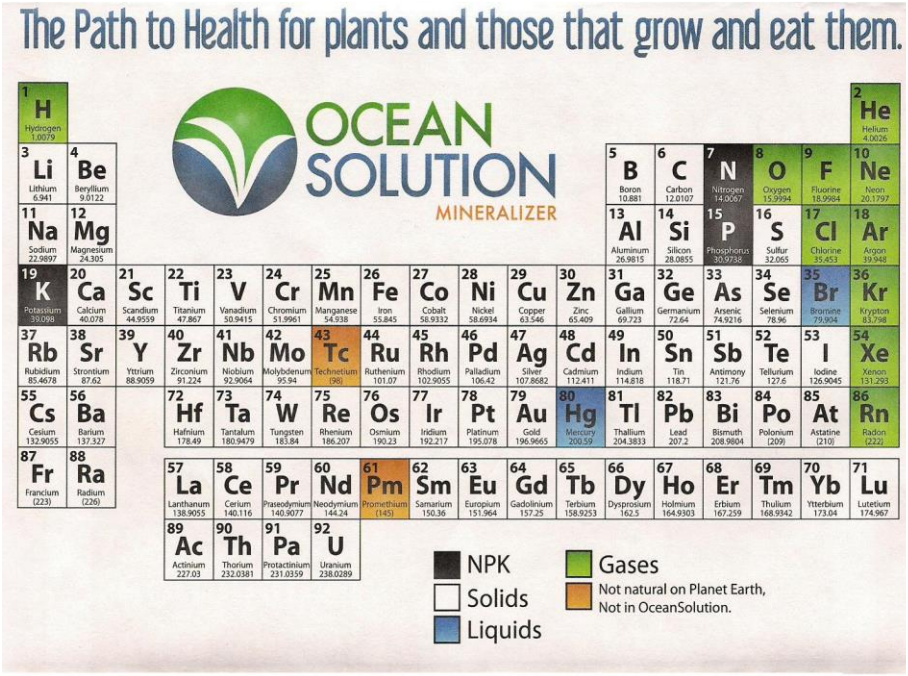
So, let us begin our journey through the elements.

The simplest atom is hydrogen, which has the chemical symbol (H). It has only one proton (a positive electrically charged sub atomic particle) in its center (nucleus) and one electron (negatively electrically charged) outside the nucleus in orbit around the nucleus. It is assigned the number one (1) also referred to as atomic number one. As we add additional protons and neutrons (electrically neutral sub atomic particles), the atoms become more complex and their chemical and physical properties change. When two protons are present, we now have the

element helium (He) and it is atomic number two (2). Every time we add a proton, the atom changes as they become larger and heavier. If there are three protons then we have Lithium, and so on.

For reference for those interested, I have included the periodic table. For the gardeners that do not have a technical background, elements in each column have very similar chemical properties. This similarity affects how all life forms use them from microbes to plants to animal and humans.

For gardeners and in our health, IF we are short of a required element, an element above or below it in the table may be substituted for the correct one. This substitution changes how the molecule performs.



Now let us begin our journey and look at each of the elements, and discover what they do in soils, microbes, plants, animals, and people.

1) Hydrogen (H) - Hydrogen is one of the most common elements in the universe and the simplest. As hydrogen is burned (fusion) in our sun, it gives off tremendous amounts of energy. It has one proton in its nucleus hence the number one on the periodic table. When two hydrogen atoms are combined with one oxygen atom, we have the molecule that we all know as water (H_2O).

We find hydrogen in all living things and in minerals and rocks. Hydrogen is found in igneous rocks like granite and basalt at 1,000 ppm (parts per million) to maybe 5,600 ppm in shales. In marine plants like Kelp, it can reach 41,000 ppm to 55,000 ppm in land plants. Hydrogen is essential for all life.

Hydrogen is a building block in many common substances like hydrocarbons (gasoline and oil) or sugar and amino acids. The human body is more than 60% water and as all gardeners know, plants require water. Hydrogen is one of the three most used elements along with carbon (C) and oxygen (O). These three elements are the building blocks of organic compounds like carbohydrates, proteins, fats, DNA and RNA as well as cellulose and lignin found in plants.

Plants combine hydrogen and oxygen derived from water, and carbon from carbon dioxide (CO_2) absorbed from the atmosphere to form glucose (a simple sugar) or more complex molecules like cellulose and lignin. The energy to do this work comes from the sun via photosynthesis.

When hydrogen is combined with nitrogen, we get ammonia and ammonium. Ammonia (NH_3), is a nitrogen atom connected to three hydrogen atoms and is often used as a common cleaning agent. If we add a 4th hydrogen atom, nitrogen atom we get Ammonium (NH_4^+) a plant nutrient.

As we mentioned earlier, scientists like to use an abbreviation of an elements name; they also like to use a "short hand" that makes it *very easy* to describe the element or molecule formed by one or more elements. For ammonia above the short hand version (NH_3), tells us that there is one nitrogen atom connected to three hydrogen atoms. The subscript after the symbol tells us how many atoms of that element there is in that molecule. For ammonium (NH_4^+), the short hand tells us that this molecule has four hydrogen atoms connected to the nitrogen atom, the superscript (+) tells us the molecule has a single positive electrical charge. When atoms have an electrical charge, we call them ions (short for ionized). If we have lots of hydrogen ions in the soil then the soil is acidic.

Gardening and Landscaping Problems Associated with Hydrogen (H)

None directly

Sources: water, leaves and grass, manures, fertilizers, sugars, most things that were once alive

2) Helium (He) - We are most familiar with this element in filling balloons to blimps as it is lighter than air (hydrogen is lighter and cheaper to use, however it is very reactive or flammable) which led to many fires. Helium is one of the "noble gases", which means that it is

inert and reacts with nothing. Helium has two protons in its nucleus and two electrons around it.

There are traces of helium in the human body absorbed from the air we breathe. It serves no known biological role in plants or animals. It mainly comes from natural gas deposits from where it becomes trapped after being formed by radioactive decay of other elements deep inside the earth. Helium does not become a liquid until it is very cold (4^0 K which is -269^0 C) or minus -452^0 F. The major use of Helium today is in physics research on super conductors, which require very cold conditions.

Helium is a very tiny atom, which is so small it can escape through the molecules that compose the walls of balloons (the reason they quickly go flat). As a result, we do not find much Helium in nature like igneous rocks at 0.008 ppm and even less in seawater.

Scientists have found a way to get Helium to react and combine with other elements (Nature Chemistry (2/17)). By using extremely high pressures, they were able to get helium and sodium to combine into a stable molecule called sodium helide (Na_2He).

Gardening and Landscaping Problems Associated with Helium (He)

None directly

Sources: oil and gas deposits, trace amounts trapped in minerals or sediment

3) Lithium (Li) - Lithium is a very light and soft metal that will float in water. Lithium is found in igneous rocks at 20-25 ppm (up to 40 ppm in acidic igneous rocks like some granites), shales at

66 ppm, limestone at 5 ppm, and seawater at 0.18 ppm and in soils at 30 ppm. When Lithium is in the ion form (Li^+) it easily moves around in soils. Lithium is found at 5 ppm in marine plants, marine animals at 1 ppm, land plants at 0.1 ppm, and land animals at 0.02 ppm. In undisturbed natural soils, it is found from 13-28 ppm and is highest in heavy loamy soils and the least in sandy soils. In the coastal plains, it ranges from 4-6 ppm.

It is used in hundreds of consumer devices from batteries, plastics, and ceramics to pace makers. Lithium is used to make lithium-ion batteries that are used in almost all modern battery powered devices from cell phones and computers to electric cars. Due to worldwide demand the price of lithium has been steadily increasing. Recent research has discovered that the water used in fracking shale for oil and gas accumulates a large amount of lithium from the shale and in concentrations that may make it a source of lithium in the future.

It was often used to fortify foods, and up till 1950 there was a Bib-label lithiated lemon lime soda now known as 7-Up.

Since 1915 the risk of clinical depression has doubled with each generation and occurs at younger ages. Since Lithium is not considered an essential plant nutrient, it was not replaced as the various crops used it up. Secondly, most artificial fertilizers tend to make the soil very acidic, hence to counter act this acidity, farmers apply large amount of lime (calcium oxide CaO) or limestone (calcium carbonate $CaCO_3$) to their fields. This practice creates excess calcium in our soils which effects/reduces the absorption of lithium by plants if it was even present anymore.

Each generation of farmers have used more and more artificial fertilizers; as the toxic chemicals destroyed the fertility of their fields there is rarely any lithium in our food supply. New studies are revealing the link to the mental problems we see in society today.

Lithium has been used for decades by psychiatrists to treat depression and other mental disorders. Animal studies have shown that a lithium deficiency results in reproductive failure, infertility, reduced growth rate, and multiple behavioral problems. Studies in Texas, California, and Oregon found that normal healthy people had 400 times the lithium in their hair than violent criminals. When Lithium is in the metallic form, it is not biologically available. A deficiency has been linked to several forms of cravings.

In the Special Winter Edition 2016 of Life Extension, it was reported that lithium inhibits an enzyme that cause formation of abnormal tau proteins and neurofibrillary tangles that destroy brain cells and impair memory.

In the Special Winter Edition 2018 of Life Extension that lithium is especially useful in treating bipolar disorder. It also helps protect against cerebral cortex thickening, builds gray matter density, and is associated with hippocampal enlargement protection.

An article in the Journal Neuroscience (January 2018) found that lithium helps with memory enhancement and helps with disordered sleep due to excess alcohol consumption.

A study published in the December 2019 Journal of Alzheimer's Disease has found that micro doses of lithium in the right form helps prevent and reverse Alzheimer's Disease.

Published in the *British Journal of Psychiatry (2020)*, the study collated research from around the world and found that geographical areas with relatively high levels or concentration of lithium in public drinking water had correspondingly lower suicide rates.

Several animal studies have shown that adequate levels of lithium increase their lifespan up to 18% as it has been found to activate a protein that protects cells against damage.

Where lithium is naturally present in the drinking water people live longer and healthier lives. Lithium has been found to help regulate genes related to healthy DNA structure. It is also associated with improvements in mood.

Lithium has been found to be associated with the amino acid histidine and has been shown to help protect brain cells. Lithium is now considered an essential element for humans.

Food sources of lithium are grains, vegetables, mustard, kelp, pistachios, dairy (grass fed), and meat.

Gardening and Landscaping Problems Associated with Lithium (Li)

As the primary rocks (minerals) break down, Lithium is incorporated into clay minerals or is easily absorbed by organic matter.

As a result, it is readily available for plants. The ability to absorb or tolerate Lithium varies between plant families. Members of the *Rosaceae* family often have 0.6 ppm in their tissues. For the *Polygonacceae* they will only have 0.04 ppm. The *Solanaceae* have the most Lithium with levels reaching 1,000 ppm.

Historically, Lithium is not considered to be an essential plant nutrient. However, newer studies have shown that it can affect plant growth and development.

Even though not essential for plants, the above studies show that it is extremely important for animals and humans. If it is not in the soil, then microbes and plants cannot absorb it, and excess calcium (Ca) in the soil inhibits Lithium uptake by plants.

Sources: granite and basalt sands, remineralizer.